Berkeley Gas-filled Separator Efficiencies

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A series of reactions have been run in the Berkeley Gas-filled Separator (BGS) to measure the separator efficiency as a function of target / projectile asymmetry.

The efficiency for separation and collection of compound nucleus evaporation residues (EVRs) at the BGS focal plane is mainly dependent on their initial spatial, angular, and energy distributions when exiting the target. These distributions are largely determined by energy loss and multiple scattering as the EVRs pass through the remaining target material.

Table 1. BGS Efficiency Measurements.

Reaction	v/v_0	εCalc	εBGS	ref. σ‡
^{197}Au(^{12}C,3n)^{206}At	0.86	0.02	0.02	catcher
^{208}Pb(^{16}O,4n)^{222}Th	1.08	0.05	0.10	Munich
^{238}U(^{22}Ne,4n)^{256}No	1.26	0.06	N.A.	Dubna
^{197}Au(^{22}Ne,5n)^{214}At	1.42	0.08	0.09	catcher
^{181}Ta(^{25}Mg,4n)^{202}At	1.73	0.12	0.09	catcher
^{181}Ta(^{26}Mg,4n)^{203}At	1.75	0.12	0.13	catcher
^{208}Pb(^{40}Ar,3n)^{245}Fm	2.25	0.40	1.10	GSI
^{208}Pb(^{48}Ca,2n)^{254}No	2.53	0.45	0.25	GSI
^{120}Sn(^{64}Ni,xn)$^{184-x}$Pt	4.33	0.80	0.40	ANL

‡ Efficiencies based on cross sections measured at indicated lab. Catcher means a direct comparison with production rates measured at the BGS target.

For the more asymmetric target / projectile combinations, the absolute production rate of EVRs was measured by collecting directly behind the target in a 1-mg / cm^2 carbon catcher foil and and measuring the decay rates of the EVRs in this foil. The BGS efficiency was then determined by measuring the same decay rates in the BGS focal plane detector (and correcting for a 50% detector efficiency for α particles). These measurements resulted in efficiency measurements with relative errors of ~20%.

The catcher method does not work for the more symmetric target / projectile combinations because the EVR recoil ranges are too long, and the energy loss of the primary beam in the carbon foil is too high. For these reactions, we have compared the detection rate in the BGS focal plane detector with those calculated using absolute cross sections measured at other laboratories. Because of inter-laboratory systematic differences, these efficiency measurements appear to be accurate to only within a factor of two.

Table 1 shows these various reactions, together with the velocity of the EVRs in units of the Bohr velocity. The calculated and measured BGS efficiencies are shown in the table, and reproduced in Fig. 1. The Monte Carlo simulation of the BGS efficiencies reproduces the measured efficiencies within experimental errors.

Footnotes and References

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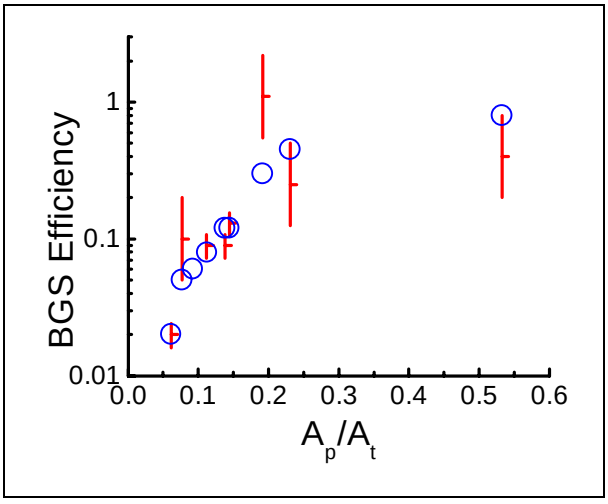

Fig. 1. Efficiencies for collecting EVRs on the BGS focal plane detector as a function of the ratio of target to projectile mass numbers. The experimental efficiencies and error limits are

shown by the red bars, and the blue circles show efficiencies calculated with a Monte Carlo simulation of the BGS.